CHAPTER 10

UNDERDRAINS

Introduction
718.01

By reducing the moisture content of the subgrade it will be more stable and thus the pavement will last longer. An easy way to do this is to place underdrains which are composed of the following:

* A trench excavated along the edge of the pavement deep enough to drain the subgrade and with adequate slope to drain properly.
* A perforated pipe or pipe with open joints placed in the trench bottom to provide for entry and transmittal of water.
* Trench backfill with granular filter material to allow ready entry of water from any soil layer above the bottom of the underneath pipe.

Types

The types of pipe allowed for underdrain installations by Specification 718.00 are as follows:

* Corrugated Polyethylene Drainage Tubing
* Corrugated Polyethylene Pipe, Type SP
* Non-Reinforced Concrete Pipe
* Perforated Polyvinyl Chloride Semicircle Pipe
* Profile Wall Polyvinyl Chloride Pipe

Types (cont'd)

The item usually specified in the contract is "Type 4 Pipe" for underdrains" and per Standard Sheet MP any of the above items may be used. Outlet pipes for underdrains will be non perforated sections of one of the above metal pipes.

The item most often used is the plastic corrugated drainage pipe. It comes in long rolls reducing the number of splices, is very durable, easily cut, easily spliced, and performs very well. PVC Pipe Schedule 40.

Pre-Construction

Due to the stabilizing effect of underdrains on the highway subgrade it is one of the most important phases of the work and must be installed properly. A major key to proper installation of underdrains is properly planning their installation.

Prior to installation the PE/PS should review the project as to the need for underdrains. Granular, less than 10% passing the #200 sieve, materials in will drained fills should not require underdrains. Exercise caution though and advise the contractor building a granular fill that the underdrains will be eliminated if the same granular material is brought up to subgrade elevation. Do not just eliminate them because a new borrow source could provide clay for final lifts.

Prior to installation, the technician should review the project for positive underdrain drainage.

* Check the necessity for special grades and depths. In poorly drained areas, go deeper, if possible, to ensure positive drainage. For depths up to and including 4 feet the unit price for the pipe does not change. Beyond the 4 foot depth, Specification 718.09 provides for additional payment.
* Check to see that minimum slope requirements are met. Usually the minimum slope is listed in the Plan General Notes and is 0.2 % or 0.2'/100'. Special grades will be established if the profile grade is less.
* Check outlet pipes to see if they will drain, rather than raise a length of underdrain to provide for outlet drainage it is better to relocate the outlet to where it will readily drain.
* Watch for conflicts with cross structures. Make sure there is an outlet before a structure or that the underdrain is high enough to clear it. If the outlet is into a cross structure make sure it is high enough in it to provide positive drainage. Do not allow the underdrain to saturate the subgrade anytime it rains.

Pre-Construction (cont'd)

At this time, using a Form I.C. 401A or Field Book, the technician should sketch up the underdrains showing all related items and plan quantities. This will serve four purposes:

* Familiarize the technician with the work.
* Help to detect possible conflicts.
* Show where special grades and depths are required.
* Provide a sheet for the Final Construction Record showing quantities actually placed. If plan quantities change merely cross them out and write in the placed quantities.

The I.C. 401A or Field Book should be set up as shown on Sheets UD 1 and UD 2. Sheet UD-1 showing how it will look when set up prior to the work. Sheet UD-2 showing how it will look after the completion of the work.

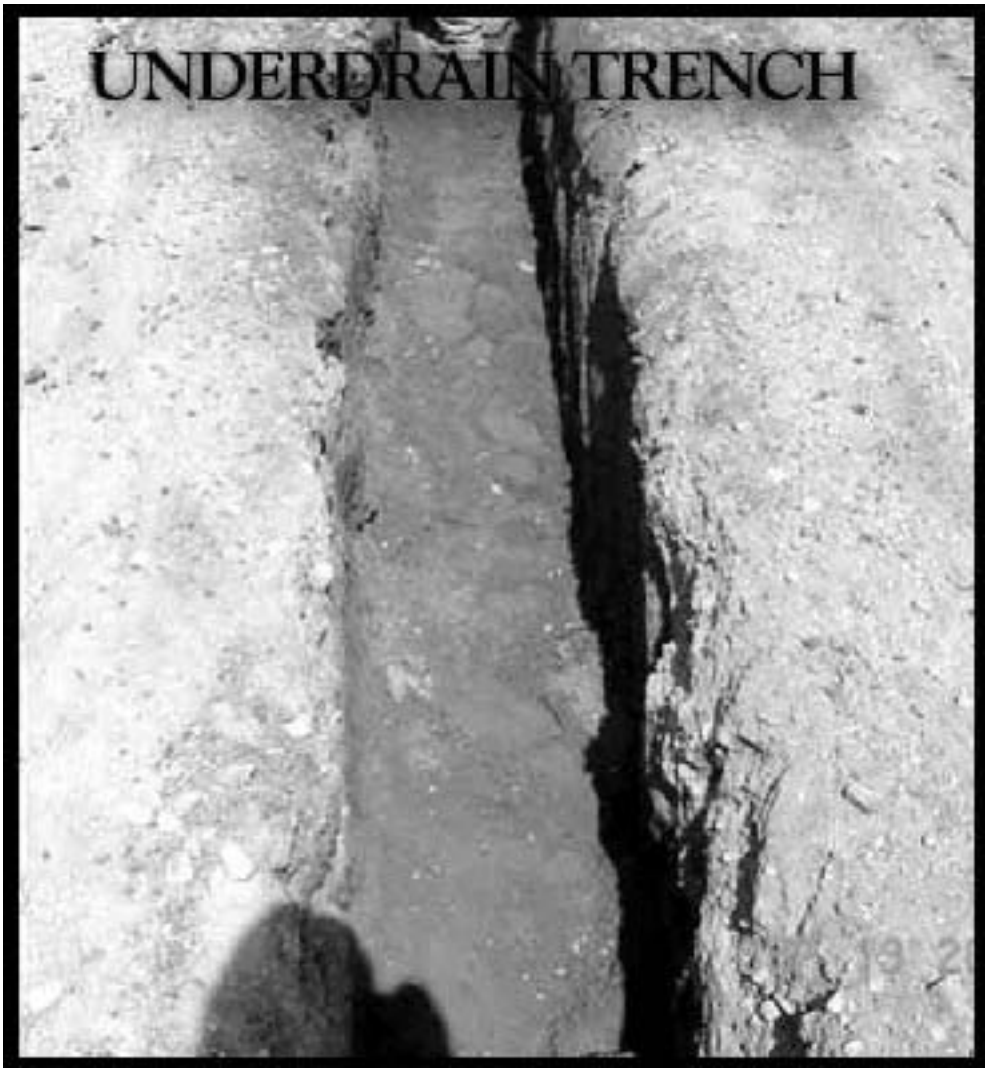
Construction 718.03

Underdrains should be placed as soon as possible after the subgrade is substantially complete. This will promote positive drainage and expedite construction. Construction should be as follows:

* Trench excavation should begin at the outlet end and proceed towards the upper end.
    ** Trench excavation made to required line and grade. Check the trench depth to ensure that the depth paid for is obtained.
    ** Trench bottom to the shape shown on Standard Sheet 718-UNDR-01 thru 718-UNDR-07.
    ** Recesses cut in trench bottom to receive any projecting pipe hubs or bells.
    ** If the trench is excavated too deep backfill it to the required elevation with approved soil.
    ** Watch for cave-ins and re-excavate if necessary.

Construction (cont'd)

* Pipe is laid into trench. See that splices and other connections are correctly made.
    ** Lay perforated pipe with holes down. This will help keep out silt, gravel, and other solids.
    ** Plastic corrugated drainage pipe is just unrolled into the trench.
* Minor cave-ins that occur after pipe placement may be ignored.
* Backfill trench with # 8 Stone, slag, or gravel. This is best done with a device designed to fill the trench without promoting cave-ins.
* Prior to placing open graded bituminous above the underdrain aggregate make sure the underdrain aggregate is clean and exposed to facilitate drainage.
* Place pipe screens in the end of the outlet pip as shown on Standard Sheet 718-UNDR-06.



Materials And Basis For Use

All materials in an underdrain installation must meet the requirements of Specification 718.02. Specific specifications and Material Record Basis for Use Requirements for the most commonly used items are as follows:

Plastic Corrugated Pipe:

* Specification 906.17
* Basis for Use is a Type 'A' Certification and a visual inspection for required dimensions and workmanship.

Aggregate

* Specification 903.02
* For less than 100 Tons/Week no sample required. Use Basis for Use number for the Minimum Quantity Option.
* For greater than 100 Tons/Week one sample for each 1,000 Tons but not less than 1 per week. The Basis for Uses will be the "D" number from the CAP source.

Measurement And Payment 718.08

Underdrains and outlet pipes are measured and paid by the linear feet installed.

* Tee and wye fittings are measured along the centerline of the barrel and an additional 5 feet of the same diameter pipe is paid for making the connection. If one of the pipes is a smaller diameter then the five additional feet will be paid at the price of the smaller diameter pipe.
* Elbow connections are measured along the center-line of the elbow and an additional 2 feet of the same diameter pipe is paid for the connection.
* Increaser and reducer connections are measure by the length of the connection and are paid at the price of the larger diameter pipe.
* Sub-tee connections are measured and paid the same as a tee connection. Payment also includes the required connecting bands, cement mortar beads or concrete collars.

Measurement And Payment (cont'd)

Aggregate is measured by cubic yards complete in place to excavated lines. The trench width shall not extend past neat lines shown on the plans and the trench shall be as specified.

Documentation for measurement and payment should be on the I.C. 401A or Field Book discussed in the Pre-Construction Section. Correct the plan quantities written previously to show the actual quantity placed.

Materials
718.02

Materials

Materials shall be in accordance with the flowing:

B-Borrow for Structure Backfill…… 211.00

Coarse Aggregate, Size No. 8 or 9,
Class E or Higher…….. 904.02
Concrete, Class A…….. 702.00
Geotextile for Underdrains…… 913.19
Reinforcing Steel……... 910.01
Sod, including Nursery Sod……... 621.00
Underdrain Pipes…… 715.02(d)
Underdrain Outlet Pipes……. 907.24

Rodent Screens

Rodent screens shall be woven stainless steel wire mesh or galvanized hardware cloth. Coarse aggregate No. 8 or 9 shall be used for 6 in. underdrain installations. Coarse aggregate No. 9 shall be used for 4 in. underdrain installations.

HMA for undredrains shall be in accordance with 402 for HMA No. 8 or 9 Binder.

Construction Requirements

Pipe
Installation
718.03

Trenches shall be excavated to the dimensions and grade shown on the plans. Pipes shall be secured to ensure that the required grade and horizontal alignment of the pipe are maintained. Perforated pipe shall be placed with the perforations down. The pipe sections shall be joined securely with the appropriate couplings, fittings, or bands. Aggregate for underdrains shall be placed in a manner which minimizes aggregate contamination.

If plain end concrete pipe is being laid, no joint width shall not exceed ¼ in.

Geotextiles

Geotextile
718.04

Storage and handling of geotextiles shall be in accordance with the manufacture's recommendations. Each geotextile roll shall be labeled or tagged. Damaged or defective geotextile shall be replaced as directed. The geotextile shall be placed loosely, but with no wrinkles or folds. The ends of subsequent rolls of geotextile shall be overlapped a minimum of 1 ft. The upstream geotextile shall be overlap the downstream geotextile. Placement of the aggregate shall proceed following placement of the geotextile.

Underdrain Outlets

Underdrain
Outlets
718.05

After the outlet pipe installation, the trench shall be backfilled as shown on the plans. B Borrow for structure backfill shall not extend into the limits of the underdrain trench. The trench outside the limits of B borrow for structure backfill shall be filled with materials suitable for growing vegetation. Aggregate and stabilized materials removed from an existing shoulder shall not be used as backfill and shall be disposed of in accordance with 206.07. At the time of installation, a rodent screen shall be placed on the outlet pipe or the ends of the underdrain pipe when located in inlets or catch basins.

Underdrain Outlet Protectors

Outlet Protectors 718.06

Underdrain outlet protectors shall be constructed as shown on the plans. Types 1, 2, and 3.

Video Inspection

Video Inspection 718.07

Underdrains and outlets shall be inspected using high resolution, high sensitivity, waterproof color video camera/recording equipment.

The camera/recording equipment shall be specifically designed for continuous viewing/recording of detailed images of the interior wall of pipes and transitions of the specified sizes. The equipment shall have capability of viewing a minimum of 450 ft. into the pipes and shall be designed to include sufficient lighting to view the entire periphery of the pipe. The equipment shall have appropriate attachments to maintain a position in the center of the pipe and an electronic counter to continuously record the location of the equipment in the pipe. The recording equipment shall be a minimum four head industrial grade VHS recorder or a digital archiving and reviewing for printing observations during inspection.

The Engineer will determine the runs of the underdrain installations to be inspected. Video inspection shall be conducted after guardrail, lighting, sign installation, and final seeding or sodding operations are completed.

Damage discovered by the video inspection shall be repaired. Damage shall include but is not limited to; crushed or partially crushed pipes that impedes the progress of the camera, blockages, vertical pipe sags filled with water depth of d/2 or greater, 90 degree connections, connector separations, cracks or splits in the pipes. All repaired sections shall be video reinspected prior to acceptance. A copy of the video inspection shall be submitted to the Engineer.

Method of Measurement

Method of Measurement 718.08

Underdrain and outlet pipe will be measured in accordance with 715.11. Outlet protectors will be measured by the number and type of units installed.

B borrow for structure backfill will be measured in accordance with 211.09. HMA for underdrains will be measured by the ton.

Aggregate for underdrains will be measured by the cubic yard, complete in place. The pay limits will not extend beyond the neat lines shown on the plans.

Geotextiles will be measured by the square yard based on the neat limits shown on the plans.

Video inspections for underdrains will be measured by the linear foot as determined by the electronic equipment.

Rodent screens, elbows, increaser or decreaser connections, and other incidentals will not be measured for payment.

Concrete, reinforcing steel, or sod for underdrain outlet protectors will not be measured for payment.

Basis of Payment

Basis of Payment 718.09

The accepted quantities of underdrains and underdrain outlet pipe will be paid for in accordance with 715.12. Aggregate for underdrains will be paid for at the contract unit price per cubic yard. Geotextile for underdrains will be paid for at the contract unit per square yard. Outlet protectors will be paid for at the contract unit price per each of the type of unit installed, complete in place. The accepted quantities of HMA for underdrains will be paid for at the contract unit price per ton.

B borrow for structure backfill will be paid for in accordance with 211.10.

The final accepted quantity video inspection for underdrain will be paid for at the contract unit price per linear foot.

Payment will be made under:

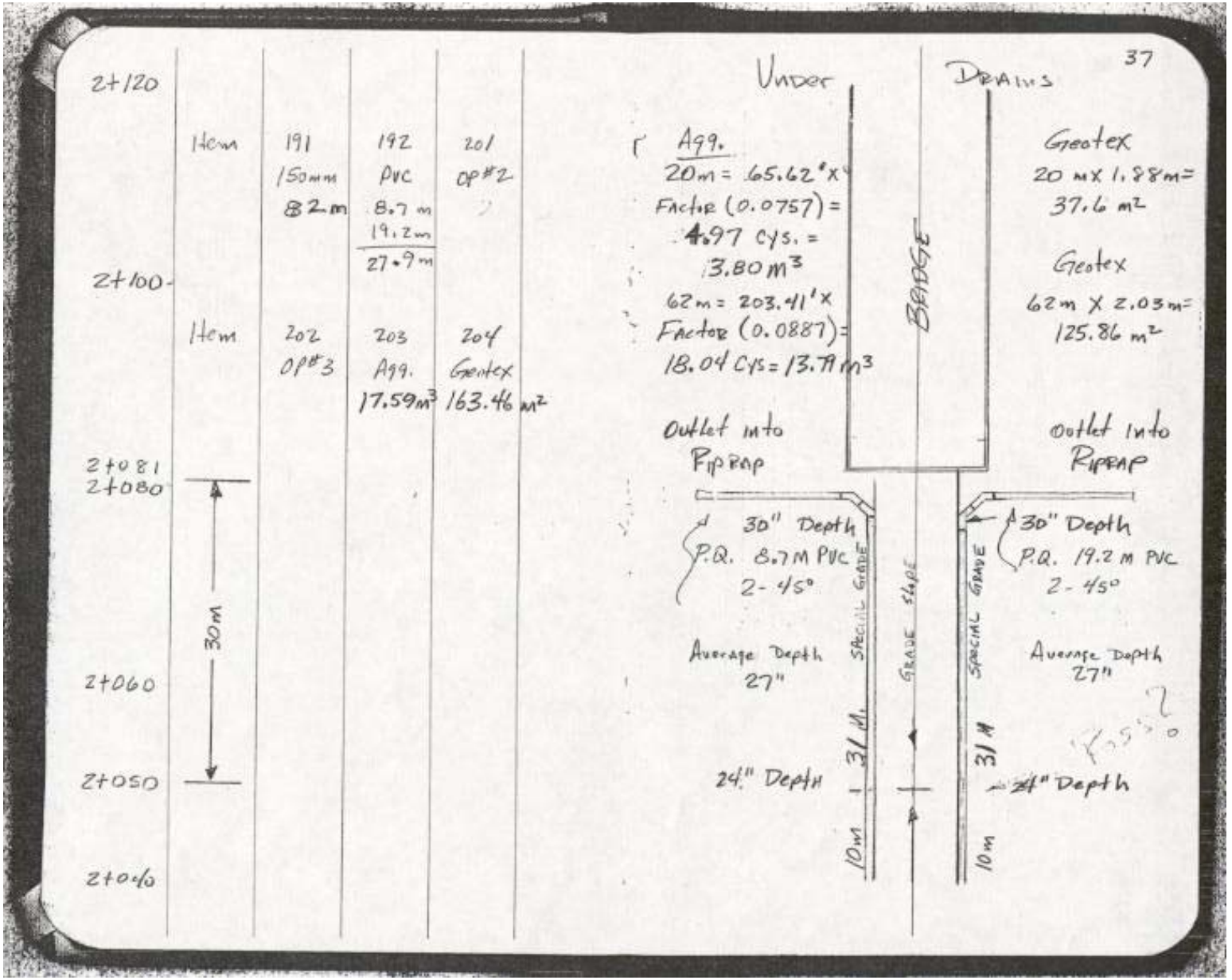
English Pay Item	English Pay Unit Symbol
Aggregate for Underdrains……	CYS
Geotextile for Underdrains……	SYS
HMA for Underdrains……	TON
Outlet Protector, _____ type	EACH
Video Inspection for Underdrain……	LFT

Geotextile for underdrains which has been rejected due to contamination or other reasons shall be replaced with no additional payment.

The costs of excavation, forming, reinforcing steel, concrete, curing materials, and sod shall be included in the cost of outlet protector.

The cost of providing the video inspection equipment, technician, videotapes, or computer disks shall be included in the cost of the underdrain video inspection. The cost of repair of underdrain pipes, aggregates, backfill, outlet protectors, geotextile fabric, etc. shall be included in the cost of the other pay items. The cost of providing video reinspection of the repairs shall included in the cost of the pay items.

The costs of disposal of unsuitable excavated materials, installation of pipe end caps, rodent screens, elbows, increaser or decreaser connections, and other incidentals shall be included in the cost of other pay items.


37
Under Drains
2+120
2+100
2+081
2+080
2+060
2+050
2+040
Item 191 150mm 82m
192 PVC 8.7m 19.2m 27.9m
201 OP#2
Item 202 OP#3
203 Agg. 17.59m³
204 Geotex 163.46m²
30m
Agg.
20m = 65.62' x
Factor (0.0757) =
4.97 cys. =
3.80 m³
62m = 203.41' x
Factor (0.0887) =
18.04 cys = 13.79 m³
Outlet into Riprap
30" Depth
P.Q. 8.7M PVC
2-45°
Average Depth 27"
24" Depth
Special Grade
31 M
10m
Grade Slope
Geotex
20 m x 1.88m =
37.6 m²
Geotex
62m x 2.03m =
125.86 m²
Outlet into Riprap
30" Depth
P.Q. 19.2 M PVC
2-45°
Average Depth 27"
31 M
24" Depth
10m

FORM I.C. -401A State Form 35928R
REV. 5-1-62

INDIANA DEPARTMENT OF HIGHWAYS

Page No.

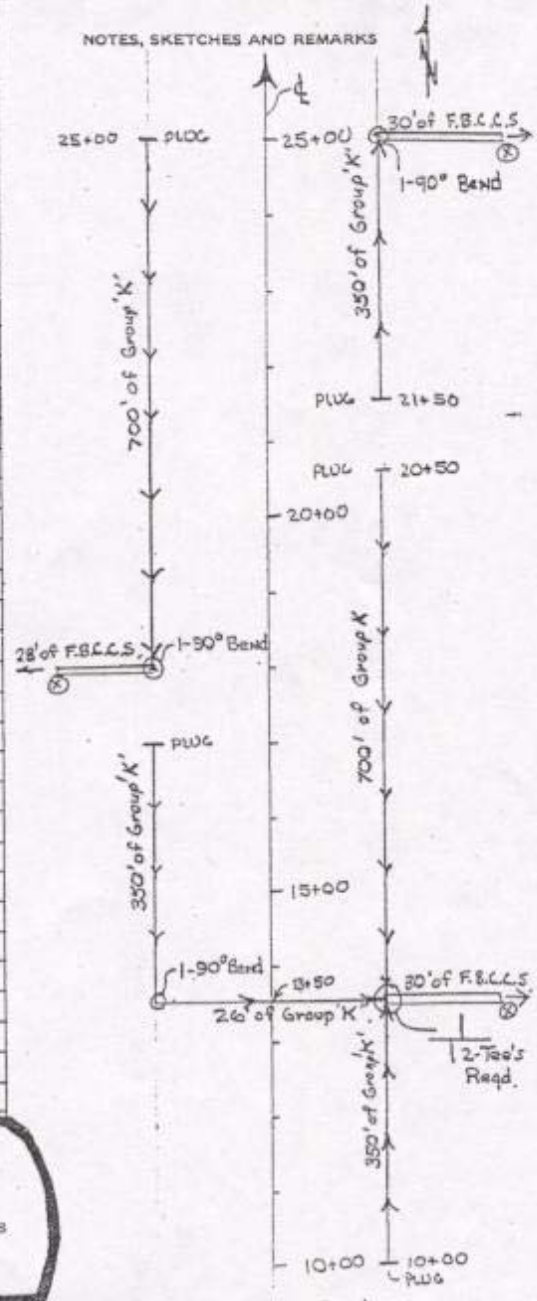
CONSTRUCTION RECORD

M-N Project No. 326(1) Section Contract No. R-14212

ITEM 6" Pipe - Gr. "K" For Underdrains ITEM No. 31

	STATIONS	Depth ~~END WIDTH~~ FEET	Av. Depth ~~SUM OF END WIDTHS~~ FEET	Length ~~LINEAL DISTANCE~~ Group 'K'	Volume/Ft. ~~AREA SQ. FT.~~ *	TOTAL Volume
Left	13+50	2.6				
	17+00	2.6				
	18+00	2.0				
	18+50	2.2				
	19+00	2.4				
	19+50	2.5				
	20+00	2.6				
	25+00	2.6				
Right	10+00	2.0				
	13+00	2.0				
	13+50	2.2				
	16+50	3.4				
	17+00	3.4				
	17+50	3.3				
	18+00	3.2				
	19+00	3.2				
	19+50	3.1				
	20+50	3.1				
	21+50	2.5				
	25+00	2.5				
TRANSVERSE AT 13+50	13'Lt.	2.6				
	13'Rt	2.2				

NOTES, SKETCHES AND REMARKS



Set up, prior to underdrain placement, of an I.C. 401A for a 2 lane highway. One side of a four lane divided highway will be similiar. See next page for changes and additions made to this form during underdrain placement.

⊗ Delineator Post Required

* From Table 107, Final Construction Record Guide.

COMPUTED BY

10 - 7

CHECKED

Sheet UD-1

FORM I.C. 401A State Form 25928R
REV. 9-1-83

INDIANA DEPARTMENT OF HIGHWAYS

CONSTRUCTION RECORD

M-N Project No. 326(1) Section ______ Contract No. R-14272

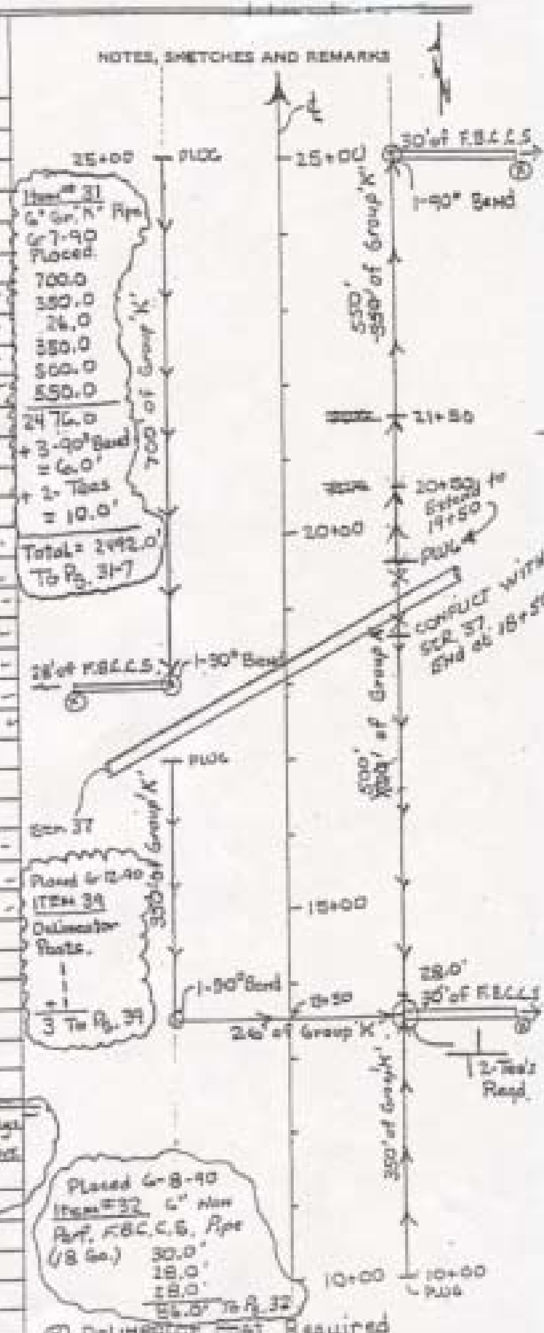
ITEM 6" Pipe - Gr. "K" For Underdrains ITEM No. 31

Stations	Depth Feet	Av. Depth Feet	Length	Volume/Ft. Group 'K' *	Total Volume
Left					
13+50	2.6	2.6	350'	.1005	35.18
17+00	2.6				
18+00	2.0	2.1	50	.0789	3.94
18+50	2.2	2.3	50	.0875	4.38
19+00	2.4	2.4	50	.0919	4.60
19+50	2.5	2.6	50	.1005	5.02
20+00	2.6	2.6	500	.1005	50.25
25+00	2.6				
Right					
10+00	2.0	2.0	300	.0746	22.38
13+00	2.0	2.1	50	.0789	3.94
13+50	2.2	2.8	300	.1092	32.76
16+50	3.4	3.4	50	.1351	6.76
17+00	3.4	3.4	50	.1351	6.76
17+50	3.3	3.2	50	.1264	6.32
18+00	3.2	3.2	50	.1264	6.32
~~19+00~~ 18+50	3.2				
~~19+50~~	~~3.7~~				
~~20+50~~	~~3.1~~				
19+50	2.3	2.4	100	.0919	9.19
20+50	2.4	2.4	100	.0919	9.19
21+50	2.6	2.5	350	.0962	33.67
25+00	2.5				
Transverse at 13+50					
13' Lt.	2.6	2.4	26	.0919	2.38
13' Rt.	2.2				
				Total	243.04

Total 243.04 cyd. Item #33 App. For Underdrains To Pg. 33

I.C. 401A after completion of underdrains showing quantities placed.

NOTES, SKETCHES AND REMARKS



* From Table 107, Final Construction Record Guide.

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